ASSESSEMENT OF DIARRHOEAL DISEASE ATTRIBUTABLE TO WATER, SANITATION AND HYGIENE AMONG UNDER FIVE IN KASARANI, NAIROBI COUNTY

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DECLARATION

This thesis is my original work and has not been presented for a degree in any other university.

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CASELAP

DEDICATION

To my three sons: Kelvin, Ian and George who are currently pursuing various educational programmes at different institutions.

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LIST OF ACRONYMS

BDL	BELOW DETECTABLE LEVEL
DHS	DEMOGRAPHICS HEALTH SURVEY
EDC	EPIDEMIOLOGICAL DISEASES CONTROL
EMCA	ENVIRONMENTAL MANAGEMENT AND CORDINATION ACT
E.COLI	ESCHERICHIA COLI
GWAKO	GROUND WATER ABSTRACTION IN KENYA UTREACH
HMIS	HEALTH MANAGEMENT INFORMATION SYSTEMS
HHWC	HOUSEHOLD WATER CONTAINER
HHT	HOUSEHOLD WATER TAP
MDGs	MILLENIUM DEVELOPMENT GOALS
LDHI	LOW DENSITY HIGH INCOME
MDMI	MEDIUM DENSITY MEDIUM INCOME
MOH	MINISTRY OF HEALTH
HDLI	HIGH DENSITY LOW INCOME
ISLI	INFORMAL SETTLEMENTS LOW INCOME
NDDIS	NATIONAL DIGESTIVE DISEASES INFORMATION CLEARING HOUSE
NWSCO	NAIROBI WATER AND SEWERAGE COMPANY
ORT	ORAL REHYDRATION THERAPY
T.COLI	TOTAL COLIFORM BACTERIA
UNICEF	UNITED NATIONS CHILDREN'S FUND
UNDP	UNITED NATIONS DEVELOPMENT PROGRAMME
WASH	WATER SANITATION AND HYGIENE
WHO	WORLD HEALTH ORGANISATION

ABSTRACT

Cause of diarrhea is known to have many risk factors. They include unsafe water, lack of water leading to low personal and domestic hygiene, poor water infrastructural and management systems. Contamination of drinking water is known to be a problem in many developing countries. This is even of more concern in high residential low income areas. Nairobi City is not an exception hence this study was conducted in Kasarani to assess diarrhea disease attributed to water, sanitation and hygiene (WASH) among under-fives. The study aimed at determining the quality of water the households were consuming. The main objective of this study was to establish the association between diarrhea among the under-five and water, sanitation and hygiene. To achieve this goal, the study area was categorized in four study environs namely low density high income (LDHI), medium density middle income (MDMI), high density low income (HDLI and informal settlement low income (ISLI). The study adopted a cross-sectional study design. The study used both structured questionnaire and hygiene observational checklist as data collection instruments. To ascertain disease trends among the under fives, the study reviewed disease records from licensed health facilities. Derived values of tables, percentages, graphs and ratios were adopted for data presentation. To determine association and significant differences between variables, data were subjected to inferential statistics and Chi-square tests respectively. For comparisons of quantitative variables, ANOVA test was used. The findings of this study indicated that Nairobi water and sewerage company (NWSCO) was the main source of water supply in the study environs (100%). Under five children from household consuming less than 60.75litres a day and who were predominantly from (ISLI) were at a higher risk of diarrhoea compared to those who consumed more than 60.75 litres a day ($p<0.001$). Households experiencing water shortages in frequencies of less than three days were found to carry a higher risk for childhood diarrhoea ($p< 0.001$). This study determined that water consumed in Kasarani was a risk for childhood diarrhoea ($p=0.019$) with tap water showing a significantly higher contamination 13.7% than household water container 7.2% for T. Coli bacteria. The microbial results observed attributed contamination to the distribution network or household and personal hygiene among the MDMI, HDLI and ISLI residential environs. Overall, the results indicated that the amount of water a household consumed per day was an important risk factor for childhood diarrhea in the study environs ($p= 0.001$). The study observed that Age of a child ($p=0.046$), Water treatment method ($p=0.002$), method of storage of solid waste $p<0.001$, quantities and frequencies of water supply ($p<0.001$) were found to be the most important risk factors for childhood Diarrhoea. The study determined that there was a significant difference in the mean Diarrhea incidences and prevalence across the residential environs ($F= 422.995$, $df=3$, $p<0.001$, $F=96.691$, $df=3$, $p<0.001$. There was a strong linear association between ddiarrhea prevalence and the different residential environs. R^2 = 0.88, 0.899 and 0.886 in the year 2008, 2009 and 2010 respectivey. The findings established that children in ISLI were the most affected by ddiarrhea. The study concluded that there was a relationship between childhood diarrhoea, water, sanitation and hygiene in Kasarani Division. These study recommended that NWSCO institute programmes that will facilitate adequate and wholesome water supply and distribution to HDLI and ISLI residential environs respectively.

CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

Diarrhoeal disease kills an estimated 2.2 million people each year (WHO, 2009). Among infectious diseases, Diarrhoea is ranked as the third leading cause of both mortality and morbidity (UNICEF, 2008). Young children are especially vulnerable bearing 68% of the total burden of diarrhoea disease (WHO/UNICEF, 2005). Among children less than five years, diarrhoea accounts for 17% of all deaths (WHO/ UNICEF, 2009).

The infectious agents associated with diarrhoea disease are transmitted chiefly through the faecal oral route (WHO, 2008). The wide variety of bacteria, viral and protozoa pathogens excreted in the faeces of humans and animal are known to cause diarrhoea. Among the most important of these are Escherichia coli (E. coli), Salmonella sp; Shigella sp; Campylobacter jejuni, Vibrio cholera, Rotavirus, Norovirus, Giandia lamblia, Cryptosporidium sp; and Entamoeba Histolytica (WHO/UNICEF, 2009).

Bacteria agents as a group are believed to cause a majority of diarrhoeal diseases in developing countries, while viral and protozoa agents tend to cause more cases in developed countries (Hunter, 1997).

Many of the diarrhoeal agents are potentially waterborne transmitted through ingestion of contaminated water (Hunter, 1997). Intervention for the prevention and control of diarrheal diseases not only include enhanced water quality but also steps to improve sanitation, increase the quality and improve access to water supply, and promote hand washing and other hygiene practices within domestic and community settings (WB, 1992). Health authorities generally accept that microbiologically safe water plays an important role in preventing outbreaks of waterborne diseases (Hunter, 1997).

Accordingly, the most widely accepted guidelines for water quality allow no detectable level of harmful pathogens at the point of distribution (WHO/UNICEF, 2005). However, an estimated 1.1 billion people lack access to improved water supplies (WHO/UNICEF, 2000). In settings that are not served by reliable water treatment and distribution systems, diarrhoeal disease is often endemic WHO/UNICEF, (2000).

With improvement in the quality of drinking water, there is evidence of increased health benefits (Esrey 1996). According to global water, ,sanitation and hygiene (WASH, 2008) fast facts, water, sanitation and hygiene have the potential to prevent at least 9.1% of the global disease burden and 6.3% of all deaths.

Further, (WHO/UNICEF, 2006) observes that improved sanitation could save the lives of 1.5 million children per year who would otherwise succumb to diarrhoeal diseases. Unsafe drinking water, inadequate availability of water for hygiene and

lack of access to sanitation together contribute to about 88 % of the deaths from diarrhoeal diseases or more than 1.5 million of the 1.9 million on children younger than 5 years of age who perish from diarrhoea each year mostly in developing countries. This amounts to 18% of all the deaths of children under the age of five leading to more than 5,000 children dying every day as a result of diarrhoeal diseases (WHO/UNICEF 2006).

In Africa and especially Sub-Saharan Africa, diarrhoeal diseases account for over 90% of deaths in children below five years old (WHO, 2007). This has been attributed to lack of safe drinking water, sanitation and hygiene as well as poor nutrition (Water Aid, 2001). Accordingly, improved water sources reduce diarrhoea morbidity by 21%, improved sanitation by 37.5% and hand washing by as much as 35% (WHO, 2005).

WHO/UNICEF, 2006 further observes that the regions with the lowest coverage of improved sanitation in 2006 were Sub-Saharan Africa (31%), Southern Asia (33%) and Eastern Asia (65%). In Kenya, diarrhoeal disease is the major cause of childhood morbidity and mortality (IDRC, 2006). According to the 2010 National Policy Guidelines to redouble diarrhoea disease management and control efforts by the Ministry of Public Health and Sanitation, untreated diarrhoea kills and is the third leading cause of death in children under five years in Kenya.

The policy also observes that, while many Kenyans have gained access to safe drinking water, the majority still lack access to proper sanitation. Globally, Oral

rehydration therapy has however dramatically decreased the mortality associated with diarrhoea but has had little effect on morbidity estimated to be approximately 4 billion cases per year (Kosek, 2003).

With continued high attack rates, diarrhoeal disease is also an enormous economic burden resulting in significant direct costs to the health sector and patients for treatment as well as in cost time at school, work and productive activities (Mulligan, 2005). An estimated 94% of the diarrhoea burden of disease is attributable to the environment and associated with risk factor such as unsafe drinking water, lack of sanitation and poor hygiene (Pruss- Ustun & Corvalan, 2006).

Traditionally, economic evaluation of water and sanitation has focused on infrastructural improvements- mainly construction of facilities to improve water supplies and excrete disposal. According to the data available at the City Council of Nairobi, Epidemiology and Disease control section for 2010, diarrhoeal diseases remain the second cause of morbidity in the children under 5 years in Nairobi with Kasarani District reporting an average of 1000 cases of diarrhoea per month (HMIS, 2010).

Arising from the observed serious public health problem, this research intended to study the association between water, sanitation, hygiene and diarrhoeal diseases among the under five years of age in Kasarani Division.

1.2. Statement of the Problem

Childhood diarrhea is a leading cause of morbidity and mortality in Nairobi City. Inspite of the ministry of public health and sanitation together with the other stakeholders in the public health sector developing health education and awareness and other environmental health programs to avert the situation, the disease continues to ravage many children below the age of five.

In deed many childhood illnesses in Kenya are water related. Diarrhea remains one of the most important childhood environmental health problems. However research has indicated that diarrhoea is a function of water, sanitation and hygiene. According to a report from Waterwiki, 2010 transmission of diarrhoea and water-related diseases are directly linked to inadequate access to water and hygiene practices.

In Nairobi City, only one third of the population is served with the conventional water and sewerage systems (NWSCO, 2008). In Kasarani study area, developments of structures and infrastructures are not fully controlled. The household income levels range from higher to lower income earners respectively. It is a mixed development with both residential and commercial activities taking place. Kasarani division has a population of approximately 525,000 people (Pop census, 2009). In most of the areas, there is no conventional drainage system.

The systems to improve sanitation are pit latrines, septic tanks and soakpits. Further, there is no conventional solid waste management system. Water supply

source is from Nairobi Water and Sewerage Company. Distribution of the water to the plots is mostly facilitated by the plot owners. The type of the water distribution pipes are not well-fitted hence constant breakages from the pressure of the many activities associated with housing and infrastructural developments and therefore resulting to probable contamination of water and limited access to household water supply.

According to the health records obtained from the City Council of Nairobi (EDC, 2011), diarrhoea-related morbidity among children under five were the most commonly reported in the 2008/2011 period in Nairobi city with Kasarani having the highest cases of diarrhoea. However, whether this risk factor has contributed to the diarrhoea situation in the study area is not documented. This research therefore, intended to establish the association between the observed diarrhoeal incidences among children under five in Kasarani Division and water, sanitation and hygiene,

1.3 Research Questions

i. What is the incidence and prevalence of diarrhoea among children under five in the study area?

ii. Is there a diarrhea risk associated with water. Sanitation and hygiene (WASH) conditions among children under five in Kasarani, Nairobi?

iii. What is the microbial quality of water used by the residents?

1.4 Study Objectives

The main objective of the study was to determine the relationship between WASH conditions and occurrence of diarrhoea episodes among the under five years of age in Kasarani, Nairobi City.

The specific objectives included:

i. To establish diarrhea incidences and prevalence of the under five years of age in the study area.

ii. To determine diarrhea risk factors associated with water, sanitation and hygiene (WASH) conditions among the under five years of age in the study area.

iii. To determine the level of bacterial contamination in the water consumed by under five in the study area.

1.5 Research Hypothesis

i. The occurrence of diarrhoeal disease among under five in Kasarani is not attributable to water, sanitation and hygiene.

1.6 Justification and Significance of the Study

Mortality and morbidity data for diarrhea incidences can be used to assess the level of health of a population in a region. The same information can be used to assess and compare the economic status of a region as demonstrated by UN MDG's in WHO regions. According to UN MGOs 2000 and Kenya Vision 2030

on health, Kenya has committed itself to reducing child mortality rate by two thirds among children under five years.

Byers (2001) observes that unsafe water, sanitation and hygiene (WASH) risk factor plays a predominant role in the outbreak of Diarrhoea disease whose transmission pathways are influenced by such factors as infrastructure, water availability, inappropriate disposal of faecal wastes and behavioural aspects. A study by Esrey et al (1996) suggests an important role for each intervention in the reduction of diarrhoea disease and also notes the health benefits resulting from the reduction in diarrhoea illnesses that relate to improvements in water, sanitation and hygiene.

The same interventions have been observed to have positive effects on the illnesses such as Schistosomiasis, Ascariasis and respiratory outcome which are also related to poor methods of excreta disposal. Conducting surveillance in order to establish diarrhea disease trend for different social economic and geographical environments can be made possible from diarrhoea incidences information.

The same information can be used to provide the basis for future projections and evaluations of different control strategies. Diarrhoea incidence data are also important indicator of the level of hygiene of individuals' sanitation and availability of improved water sources (UN, 2000). Further this information is also a tool to identify overall health inequalities in the population besides forming

the basis for identifying control priorities, effectiveness of interventions, costs and actions.

1.7 Study Assumptions and Limitations

Nairobi City has a well-established health management information system. This has been enhanced through the current decentralized Health Service delivery. This study therefore assumes that the diarrhoea incidences occurring in Kasarani have been registered through an established Health Information Systems in the surrounding health clinics. It also assumes that those health clinics are registered by the relevant Health Registration Boards.

Further, it assumes that the health records identify each of the diarrhoea incidences with age, sex, and residence. However, this study acknowledges that

there are other factors that may also influence the health outcome of a population and include state of health of the population, nutritional status, water management and distribution systems especially water distribution, storage, hygiene practices, social/cultural factors, environmental and type and use of sanitary facilities. The complexity of the relationship therefore qualifies infections and transmission of diarrhoea as illustrated in the conceptual framework.

1.8 Conceptual Framework for Diarrhea Diseases

Diarrhea prevalence is influenced by the interplay of many risk factors. Among them are:

a) **Social economic status:** These include the mother's education levels, marital status and the household's income levels.

b) **Infrastructural factors**: These factors include sanitation and living conditions for example sewerage systems, source of water supply, nature and type of toilets.

c) **Hygiene factors: T**hese factors include both household and personal hygiene behavior

d) **Demographic factors:** These factor include age and gender of the child's care giver respectively.

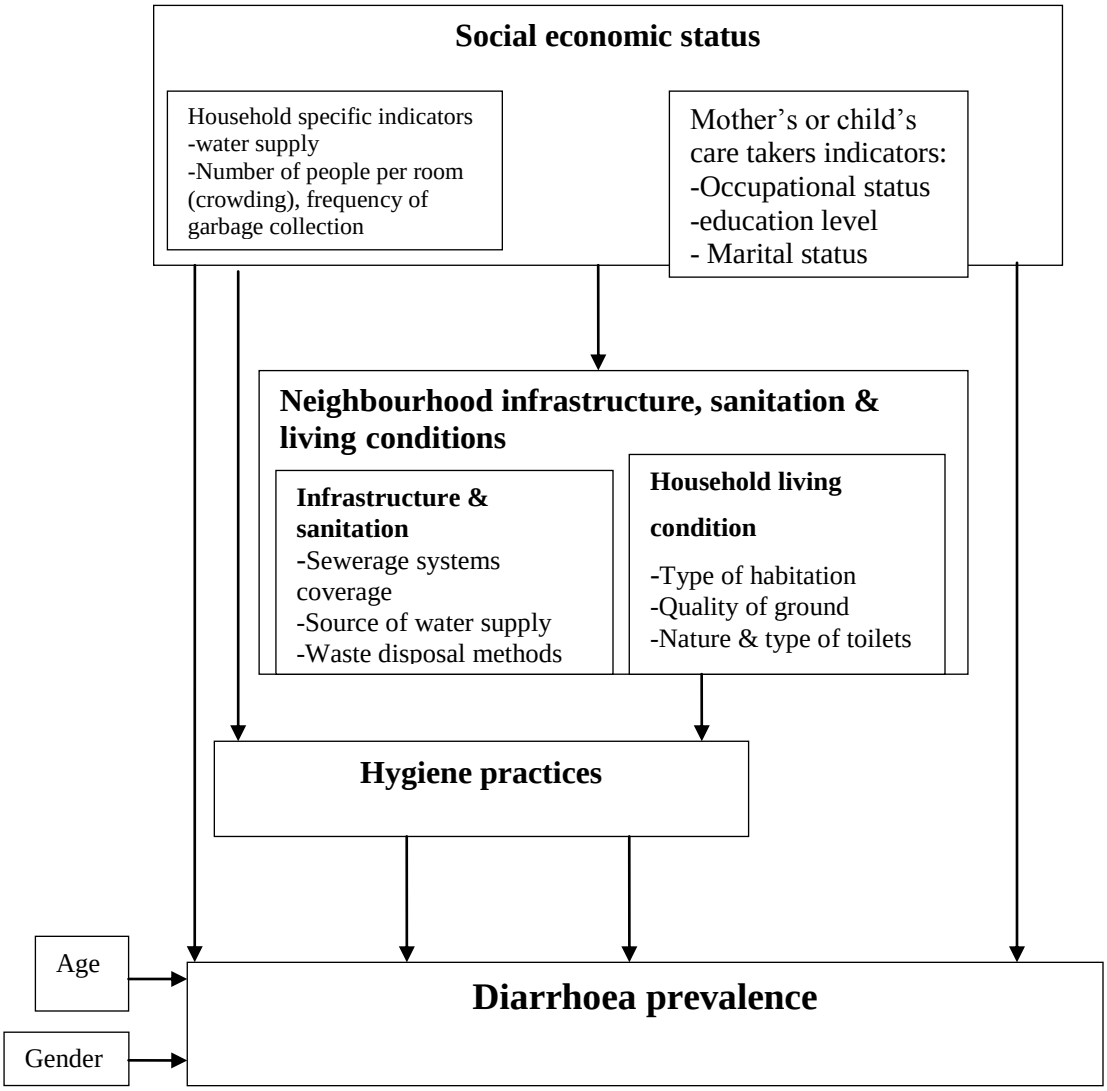

Figure 1.1: Conceptual framework visualizing the inter-relationships between potential risk factors and Diarrhea prevalence

Source: Genser B et al., Int. J. Epidemiol. 2008; 37: 831-840

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

Globally, diarrhoea is the second highest cause of mortality in children under five years of age (WHO/UNICEF, 2010). According to WHO Global Burden of disease 2004 estimates, Diarrhoea accounts for nearly 1.8 million deaths or 17% of under five mortality each year in developing countries. WHO estimates that 85% to 90% of diarrhoea illnesses in developing countries can be attributed to unsafe water, inadequate sanitation and hygiene practices (Pruess et al. 2004). Diarrhoea is defined as having three or more loose or liquid stools per day or having more stools than is normal (WHO, 2009).

It is a common cause of death in developing countries and the second most common cause of infants' deaths worldwide (Hogue, 1996). The loss of fluids through diarrhoea can cause dehydration and electrolyte imbalances. In 2009, diarrhoea was estimated to have caused 1.1 million deaths in children over five years and 1.5 million deaths in children under the age of five. Oral rehydration salts and zinc tablets are the treatment of choice and have been estimated to have saved 50 million children in the past 25 years (WHO/UNICEF, 2000).

There are many causes of infectious diarrhoea, which include viruses, bacteria and parasites. Norovirus is the most common cause of viral diarrhoea in adults but Rotavirus is the most common cause of death in children under five years old.

Adenovirus types 40 and 41 and Astroviruses cause a significant number of infections (WB, 1992). The bacterium Campylobacter is a common cause of bacterial diarrhea but infections by Salmonella, Shigellae and some strains of Escherichia Coli (E.Coli) are frequent. The organisms in the total coliform groups are called indicator organisms.

Its presence in water requires an analysis of all water systems facilities and their operations to determine how these organisms entered the water system (NPHLS, 2008). E Coli is a specific species within the Coliform bacteria. Its presence indicates a strong likelihood that human or animal wastes are entering the water system (NPHLS, 2008. Amoeba usually lives in the large intestines sometimes invading walls of the intestines forming a cyst. This causes ulcerations and bleeding with bouts of dysentery occurring. In 20% of the infected cases, no symptoms show.

It is fecal oral and spread through a cyst (WHO, 2010). Crypto infection is spread through fecal oral route and often through contaminated water. It affects the intestines and is usually acute. It is the organism most commonly isolated in HIV positive patients presenting with diarrhea (WHO, 2010). In the elderly, particularly those who have been treated with antibiotics for unrelated infections, a toxin produced by Clostridium Difficile often causes severe diarrhoea (NDDIC, 2007).

In sanitary living conditions where there's ample food and a supply of clean water, an otherwise healthy person usually recovers from viral infections in a few days (Kosek, 2003). However, for ill or malnourished individuals, diarrhoea can lead to severe dehydration and can become life threatening. According to *Moses et al 2010*, most of the pathogenic organisms that cause diarrhoea and all the pathogens that are known to be major causes of diarrhoea are transmitted primarily or exclusively by the faecal-oral route.

Faeco-oral transmission may be waterborne, food borne or direct transmission which implies an array of other faeco- oral routes such as via fingers or formites or dirt which may be digested by young children. According to a survey by Nisha and Nicholas (2010), despite the severe impact of diarrhoea on children's health and mortality in India, only half of all children suffering from diarrhoea receive treatment or medical advice. An understanding of the socio-demographic determinants for appropriate treatment of the disease is critical.

2.2 Epidemiological Study of Diarrhoea

Diarrhoeal diseases are one of the leading causes of childhood morbidity and mortality in developing countries. An estimated 1000 million episodes occur each year in children under the age of five. Diarrhoea causes an estimated 5 million deaths in children under five years of age per year. About 80% of these deaths occur in children in the first two years of life. Approximately, 1/3 of deaths among children under five are caused by diarrhoea (WHO, 1990). In Philippines,

diarrhoeal disease is the second leading cause of morbidity and mortality for all ages it is the next leading cause of infant deaths. The most important bacterial infections gain entry through the gastro- intestinal tract They include the bacillary dysenteries, cholera and enteric fevers.

This is one of the most commonest causes of childhood diarrhea. Contamination of water remains the cause of major outbreaks. It can occur through cross connection of a main with a polluted water supply, fecal contamination of wells or faulty purification. Similarly, amoebiasis and giardiasis which live in the large intestines cause ulcerations of the mucosa with consequent diarrhea. It is known to occur most in tropics and subtropical countries. Infected water has occasionally been held responsible for the transmission of large outbreaks of the disease.

Surveys done in La Union, Bohol and Bukidnonin 1985 showed that every Filipino child suffered an average of 2.8 episodes annually. Most diarrhoeal illnesses are acute, usually lasting no more than 3-5 days and are secondary to infectious causes. Infectious agents that cause diarrhoeal disease are usually spread by the faecal-oral route, specifically by ingestion of contaminated food or water and contact with contaminated hands.

The usual pathogenic mechanisms for infectious diarrhoea include toxin production, tissue invasion, or invasion of intestinal cells with consequent acceleration of their function and reproduction. The most common organisms

responsible for most cases of diarrhoea include Rotavirus, ETEC Shigella, Campylobacter, Vibrio Cholera and non-typhoidal Salmonella.

A serologic survey conducted in metro Manila In 1990 showed early acquisition of antibodies for Rotavirus. 7% of Sporadic diarrhoea was caused by Rotavirus in the community while 35% was detected in the hospital cases. Infection due to Norwalk virus was however not uncommon. More studies on the prevalence of antibodies to Norwalk virus in Manila showed that 43% of individuals would have detectable levels by age 12 years. Isolation rates for Salmonella, Shigella, EPEC, V. Cholera 01 and other Vibrios, campylobacter Jejuni and Aeromoeas SP. differed from study to study. Contrary to popular belief, Entamoeba Histolytica was detected in less than 5% of cases.

The prevalence survey done in the Philippines showed that only 5% of 14,205 stool specimens were positive for the parasite and 6% 19,771 sera had antibody titers-1,128 by indirect hemagglutination. The percentage isolation of Giardia Intestinalis was likewise low. Besides, the etiologic agents mentioned above, other conditions causing or are associated with diarrhoea include drugs, surgical conditions, other diseases e.g. (malaria, Schistomiasis, Measles), systematic infections and food intolerance. A number of pathogens have, also been associated with persistent diarrhoea and dysentery.

These types of diarrhoea are important in that they are more likely to have severe consequences. Studies have shown that one third to one half of all diarrhoea-

associated deaths among children occurred following episodes of persistent diarrhoea where dysentery accounts for 10% to 15% of diarrhoea episodes in children under the age of 5, but up to 25% of diarrhoea deaths.

Dysentery is caused primarily by bacteria which invade the epithelial cells of the small intestine and colon, produce a variety of toxins, disrupt the cell and cause an inflammatory response. A number of organisms have been found in dysentery cases and more than one pathogenic organism is found in many cases. However, Shigella is the most common (from 33% to 62% of cases in 3 studies). The second most common cause of dysentery is Campylobacter. Others include invasive E.Coli, P. Shigelloides, Salmonella and Aeromonas SP. An estimated 1.1 billion people lack access to an improved water source.

Hundreds of millions more drink contaminated water from improved sources because of unsafe water treatment and distribution systems and unsafe storage and handling practices. (UNICEF, 2006).

The health consequences of inadequate water and sanitation services include an estimated 4 billion cases of diarrhoea and 2.2 million deaths each year, mostly among young children in developing countries (WHO, 2008). In Kenya, diarrhoea ranks as the third leading cause of both mortality and morbidity among infectious diseases (Care/Kenya, 2005). According to a report by Gwako (2010), 23.3 million Kenyans do not have access to safe drinking water resulting to several deaths (mostly children).

A pilot project with the Care/Kenya in 2005 on preventing diarrhoea disease in Nyanza Province showed that water quality intervention reduced diarrhoea disease incidence in users by 22 - 84% through the Safe Water System. This included water treatment with chlorine solution at the point of use, storage of water in a safe container and behaviour change communication. Results from the project showed a 56% reduction of diarrhoea disease risk with improved hygiene level.

2.3 Morbidity and Mortality in relation to Diarrhoea Disease

Diarrhoeal diseases have long been recognized as a leading cause of morbidity and mortality, especially in developing countries (WHO, 2008). International efforts to combat this worldwide problem include the recent initiation by the World Health Organization of a diarrhoeal diseases control programme whose objective is to reduce diarrhoeal morbidity and mortality.

A study by WHO to quantify the magnitude of the global problem of acute diarrhoeal disease established that morbidity rates were highest in the 6-11 month age group while the mortality rates were greatest in infants under 1 year of age. For children under 5 years old, the media incidence of diarrhoea was 2.2 episodes per child per year for all studies and 3.0 episodes per year for the studies that had the smallest populations and most frequent surveillance.

The studies also estimated that the total yearly morbidity and mortality from diarrhoeal diseases for children under 5 years of age in Africa, Asia, were 744 +000 million episodes and 4.6 million deaths (WHO, 2008). Snyder and others

acknowledge the obvious limitations inherent in estimating the global incidence of diarrhoeal illnesses and death on the basis of data obtained in studies conducted by different researches using different methods of study discrete populations. A different study by Bern et al., (2007) observed that the median number of 2.6 episodes of diarrhoea per child per year is little different from the estimated 2.2 episodes reported by Snydes and others and is equivalent globally to an estimated 1 billion episodes each year.

The medians and ranges for mortality, among children aged less than 5 years with past population estimates yield an estimated 3.3 million deaths per year from diarrhoea, lower than 4.6 million deaths previously reported. However, the range is wide. Although there are inherent limitations in this study, it has been possible to estimate the magnitude of the problem of acute diarrhoeal diseases in the developing world.

2.4 Water, Sanitation and hygiene in relation to Diarrhoea Disease

2.4.1 Water quality and diarrhoea

The prevalence of contamination from man-made pollution and waste to naturally occurring toxins and the wide range of ways contaminated water can enter the human body are staggering. Everyday people are put at risk through drinking contaminated water, eating food prepared in bowls or with utensils washed with contaminated water, through poor personal hygiene, bathing and washing in unhygienic water.

Over 3 million people die each year nearly all from developing countries with 80% of the total disease burden coming from the poor countries (WHO, 2007). It is estimated that up to half of all hospital beds in the world are occupied by victims of water contamination.

The biggest killer is diarrhea contracted from micro-organisms in water contamination by sewage resulting in 1.8million child deaths per year. In places like Sub-Saharan Africa and south Asia, up to half of all cases of malnutrition are caused by diarrhoea. Various studies and outbreak incidences have found an association between poor water quality and diarrhoea.

In Togo water that did not meet microbiological standards was associated with increased gastroenteritis while in Philippines increased childhood diarrhea was observed following consumption of water with high levels of Escherichia Coli (Moe et al.1991). In developing countries, it is not only water contamination at source or during distribution that is an issue but also water stored within the home which may also become contaminated (WHO/UNICEF, 2007). In the United States, 14 outbreaks of infectious etiology associated with drinking water were reported for the two year period 1997-1998 (Barwick et al. 2006).

2.4.2 Sanitation and diarrhoea diseases

The health consequences of inadequate water and sanitation services include an estimated 4 billion cases of diarrhoea and 1.9 million deaths each year, mostly among young children in developing countries (Waterwiki, 2010). Diarrhoea diseases lead to decreased food intake and nutrient absorption, malnutrition, reduced resistance to infection and impaired physical growth and cognitive development. Water and sanitation interventions to reduce diarrhoea disease incidence in developing countries fall into four general categories: Water provision, household water treatment, hand washing promotion and sanitation. Each of these interventions is proven to reduce diarrhoeal disease incidence.

Survey by the Department of Physical and Health Knowledge and Practice among secondary school children in Zaria & Nigeria and diarrhoea observed that poor knowledge and practice of personal health and environmental health increased prevalence of diarrhoea among children of school age (Ingrid, 2008). Organizations are often faced with the difficult decision of where to focus limited resources in order to improve water and sanitation conditions.

Selecting the most appropriate interventions for a specific location depends on existing water and sanitation conditions, cultural acceptability, hydrology and water quality, implementation, feasibility and local conditions (Waterwiki, 2010). According to WHO Health related MDG's 4 and 7, countries were to reduce child mortality rate and also ensure environmental sustainability by the year 2015.

Currently, 1.1 billion people worldwide lack access to safe water supplies which include household connections, public standpipes, boreholes and protected dug wells, protected springs and rainwater collection (UNICEF, 2006).

According to a report by WHO/UNICEF, (2008) on global statistics on children, water and hygiene, water supply, sanitation and diarrhoea are closely related. Poor hygiene, inadequate quantities and quality of drinking water and lack of sanitation facilities cause millions of the world's poorest people to die from preventable diseases each year. Women and children are the main victims. The link between water, sanitation and diarrhoea include:-Contaminated water that is consumed and may result in waterborne diseases including viral hepatitis, typhoid, cholera, dysentery and other diseases that cause diarrhoea. Without adequate quantities of water for proper hygiene, skin and eye infections for example trachoma spread easily (WB, 2003). In some areas like Turkana, the prevalence rate is 42% (AMREF, 2011).

Inadequate water, sanitation and hygiene account for a large part of the burden of illness and health in developing countries. Approximately 4 billion cases of diarrhoea per year cause 2.2 million deaths, most of them children under the age of five with about 15% of deaths in developing countries. Diarrhoeal diseases account for 4.3% of the total global burden (62.5 million DALYS). An estimated 88% of this burden is attributable to unsafe drinking water supply, inadequate

sanitation and poor hygiene. These risk factors are second after malnutrition, in contributing to the burden of the disease.

Improving global access to clean water and sanitation is one of the least expensive and most effective means to improve public health and save lives. The concept of clean water and sanitation as essential to health is not a novel idea. Hippocrates in 350 B.C is quoted to have recommended boiling of water to inactivate impurities. A proceeding from the royal society of London on appropriate technologies for environmental health on water, sanitation and diarrhoea observes that in the developed countries where water and sanitation services are nearly universal, hygiene-related diseases have been significantly reduced.

This has been through the protection of water sources and installing sewerage systems. This however, is not the case in developing countries and as a result, millions suffer and die from preventable illnesses including diarrhoea every year. The solution lies on integrating public health into engineering problem solving. The paper recommends partnerships with local communities to implement water and sanitation solutions that consider environmental, cultural and economic conditions.

2.4.3 Hygiene and Diarrhoeal Diseases

Research by (Curtis et. al., 2003) on Myanmar experiences in sanitation and hygiene promotion observed that washing hands after defecating was protective while providing safe drinking water and more latrines and promoting hand

washing could reduce the burden of illness from bloody diarrhoea while limiting injudicious antimicrobial use. It was also observed that hand washing could reduce diarrhoea risk by 47% while hand washing with soap reduced diarrhoea risk from 42-44%.

The current evidence however indicates that hand washing with soap can reduce the risk of diarrhoeal diseases by 42-47% and interventions to promote hand washing might save a million lives. According to a study by (Hoque, 2003) in Bangladesh and elsewhere, hand washing is universally promoted in health interventions. The study has shown a 14-40% reduction of diarrhoeal diseases with hand washing. The study observes that perceptions and methods related to washing of hands vary widely. Socio-economic factors are also associated with methods practiced.

The prevalence of contamination from man-made pollution and waste to naturally occurring toxins and the wide range of ways contaminated water can enter the human body are staggering. Everyday people are put at risk through drinking contaminated water, eating food prepared in bowls or with utensils washed with contaminated water, through poor personal hygiene, bathing and washing in unhygienic water.

Over 3 million people die each year nearly all from developing countries with 80% of the total disease burden coming from the poor countries (WHO, 2007). It

is estimated that up to half of all hospital beds in the world are occupied by victims of water contamination.

The biggest killer is diarrhea contracted from micro-organisms in water contamination by sewage resulting in 1.8million child deaths per year. In places like Sub-Saharan Africa and south Asia, up to half of all cases of malnutrition are caused by diarrhoea. Various studies and outbreak incidences have found an association between poor water quality and diarrhoea.

In Togo water that did not meet microbiological standards was associated with increased gastroenteritis while in Philippines increased childhood diarrhea was observed following consumption of water with high levels of Escherichia Coli (Moe et al.1991). In developing countries, it is not only water contamination at source or during distribution that is an issue but also water stored within the home which may also become contaminated (WHO/UNICEF, 2007). In the United States, 14 outbreaks of infectious etiology associated with drinking water were reported for the two year period 1997-1998 (Barwick et al. 2006).

2.5 Management, Control and Prevention of Diarrhea diseases

A number of measures can prevent diarrhoea diseases from manifesting. They include breast feeding, which provides infants the antibodies to protect against infections. Improved weaning practices, proper use of improved weaning practices, proper use of water for hygiene and drinking, hand washing, disposal of feaces properly, vaccinations and proper nutrition. (Jailson et al., 2010). To

implement these strategies, the people must be educated about proper practices and utilize the community health workers and village health workers.

For case management, oral rehydration therapy (ORT) is the oral administration of water and electrolytes to replace existing losses, primarily accomplished by giving oral rehydration salt (ORS solutions. According to WHO/UNICEF, 1999, there is evidence that ORT was an ancient traditional practice. Research in 1990s demonstrated that the addition of glucose to salt solution resulted in absorption of salt and water across the intestines (WHO, 2005). In the absence of glucose no absorption of salt or water was observed. The same research observed a dramatic decrease in mortality rates from diarrhoea (30% to less that 3%) with the administration of ORT in refugee camps in Bangladeshi war for independence. In addition to ORT, appropriate feeding during episodes of diarrhoea is recommended.

Clinical and laboratory studies show that continued feeding during episodes of diarrhoea leads to improved outcomes in diarrhoeal diseases. They include decrease in stool output, shortened duration of illness, significant weight gain and improved nutritional status ((WHO, UNICEF, 1999). Nutritional therapy depends on the age and diet of the child. (Bell et al., 2010). For infants, the importance of breastfeeding is stressed. WHO recommends exclusive breast feeding for the first few months.

Research has shown that where mothers have to breastfeed, exclusively; there is a dramatic decrease in episodes of diarrhea (UNICEF, 2005). Breast feeding should be supplemented with ORT. Scientific research has suggested a relationship between diarrhoea and specific micronutrients deficiencies. Zinc deficiency may cause diarrhoea. Vitamin A deficiency is associated with risk of diarrhoea while folic acid may be associated with improved recovery time for acute cases of diarrhea (UNICEF, 2005).

According to WHO, 2008 drug therapy of diarrhoea should be avoided. This is because some drugs may be potentially toxic to some patients leading to adverse reactions. Non-compliance with therapy may also lead to antibiotic resistance. The WHO therefore recommends that anti-diarrhoea drugs be strictly avoided as they may prolong infection and mask signs of dehydration. Although the standard WHO/UNICEF ORS solution is effective in achieving and maintaining rehydration, it does not reduce stool volume or duration of diarrhoea illness. Super ORS have recently been developed which reduce stool and increase water absorption in the gut. A vaccine for diarrhoea caused by Rota virus has also been developed.

CHAPTER THREE

MATERIALS AND METHODS

3.1 Location of the Study

The study was carried out at Kasarani Division Nairobi County. Kasarani Division is a residential area and in the eastern part of Nairobi. The Division has seven locations. They are; Githurai, Kahawa, Kariobangi, Kasarani, Korogocho, Roysambu and Ruaraka. . Kasarani residential estates ranges from the low density high income to informal settlement low income. The infrastractural development in terms of water distribution, sewerage systems and waste disposal is either low or lacking particularly in the informal settlement unlike in the high income areas. It's about 10 km from the city centre along thika road and in Nairobi North District.

Kasarani Division has a population of approximately 525,000 people and covers an area of 86km^2 (KNBS, 2009). The housing development comprises different designs and structures. It is a mixed development for both rental and individual residence purposes.

Most of the housing developments have not been approved by the relevant institutions and enforcement of city by-laws is not adequate (NEMA, 2009). This has led to mushrooming of poorly built structures that are both permanent and semi-permanent and which poses serious public health concerns. The water supply source is Nairobi Water and Sewerage Company (NWSCO). However,

water distribution in the area is mostly through plastic pipes, each plot having a supply tap water. With the various developments taking place, breakages of pipes are common risking water contamination. This is made even more grave because in most areas, there is no convectional drainage system and the existing system is through the septic tanks, soaked pits and pit latrines. There is equally no established method of solid waste management and most residents practice indiscriminate solid waste dumping (JICA, 2010).

3.2 Study Design

This study was a cross-sectional design. The design was chosen since it was meant to determine prevalence of risk factors of diarrhoea incidences among the under five in Kasarani and examine the association with water, sanitation and hygiene. Hence a reconnaissance survey was conducted to identify the households and Health Facilities to be sampled.

To establish Diarrhea incidence and prevalence, a retrogressive purposeful study covering three years was used to evaluate data on Morbidity and mortality from the neighboring licensed health clinics. The simple random sampling method was employed to collect the water samples from the eligible Households.

Map of Kenya

Map of Kasarani

Figure 3.1 Map of Study Area in relation to its position in Kenya
Source: Google Maps

3.3Target and Study Population

The study targeted all the children below the age of five residing in Kasarani Division of Nairobi County. Kasarani Division covers an area of approximately 86km^2 with a resident population of 525,000 people (KNBS, 2009). Further, it has approximately 10500 households (CBS, 2002). Since the study targeted child caregivers as respondents the target population was 10500 households in the area. The child caregiver was however anyone who was responsible for the child at the time of the study in that household and could have been the mother, father, house help or any other person.

3.4 Inclusion and Exclusion Criteria

Households included in the study had to have members who had lived there for at least one year. The household had to be serviced with a source of water supply whether from tap or communal tap. Further the household had to have a child below the age of five years and the respondent had to be willing to participate.

3.5 Sample Size Determination

Sampling in research is the process of obtaining information about an entire population by examining only a part of it (Kothari, 2003). It serves the purpose of saving time and other resources and yet produces the required results. This happens by the researcher drawing inferences based on samples about the parameters of population from which the samples are taken. In this research, the sample size was determined using the formula by Fisher et al., (1998).

$$n=\frac{Z^2pq}{d^2}$$

Where **n**=desired sample size.

- **Z**=standard normal deviate at 95% confidence level (1.96)
- **P**= proportion of the households target population with children under five years 15% (UNEP, 2009).
- **q**=1-P
- **d**=degree of accuracy desired (0.05)

$$n=1.96^2(0.15)(0.85/0.05^2$$

$$n=196$$

3.6 Sampling Procedure

Kasarani division was conveniently selected. The residential estates of Kasarani were then clustered into four study environs based on characteristics presented in table 3.1. This followed the 2009 Kenya National Bureau of Statistics household cluster sampling methodology. Following this clustering, simple random sampling

technique was used to select participating estates according to probability proportionate to sample size.

However, before selecting sample environs, implicit stratification was achieved through first stage sampling by sorting estates using a socio-economic status (SES) indicator. To be able to select participating households in each of the selected estate, simple random sampling technique was again employed according to probability proportionate to sample size (KDHS, 2009). To determine the probability proportionate for the sample size for each cluster, the formula by Kothari, 2003 was adopted where the cluster household population was divided by the total household population and then multiplied by the total sample size. Overall, a total of 199 eligible households representing 31, 53, 56 and 59 households in LDHI, MDMI, HDLI and ISLI respectively were sampled.

Table 3.1 Estate Cluster for Kasarani study environs and corresponding households

No	Cluster	Estates	Households	Environmental Sanitation Characteristics
1.	LOW DENSITY HIGH INCOME	Kasarani Sports View Thome Mirema Drive	550 450 500	Low population Drainage system not connected to main sewer (NWSCO) Developments & Structures are controlled Solid waste management is well organized Water supply distribution pipes well maintained Waste water effluents well managed Majority of the houses are owner occupiers Water supply source (NWSCO) Sanitation methods are septic tanks and soak pits which are well maintained
2.	MEDIUM DENSITY MIDDLE INCOME	Ngumba Zimmerman Roysambu	850 1000 1000	High population Occupants both owner occupiers and tenants Source of Water (NWSCO) Waste water discharging to the surrounding environment Water supply distribution pipes poorly maintained Sanitation method is septic tanks Solid waste generation high but fairly well managed Developments& structures not fully controlled
3.	HIGH DENSITY LOW INCOME	Mathare North Manguu Githurai 44	1100 925 1000	High population Has poor drainage system Solid waste poorly managed Developments& structures not fully controlled Household are generally rental dwellings Water supply source(NWSCO) Water supply and distribution pipes poorly maintained
4.	INFORMAL SETTLEMENT LOW INCOME	Jathaini /Ngomongo Soweto Kahawa Kamae Kahawa West	1025 1000 1100	Communal toilets are the most in use. Poorly managed solid wastes Informal settlements Fairly high population and overcrowding Houses are generally for rental dwellings Water supply distribution pipes poorly managed Waste water overflowing to the surrounding environment Water supply source is NWSCO but generally inadequate and therefore supplemented from water vendors.

Ref- (KNBS, 2009)

3.7 Data Collection Instruments, Methods and Techniques

3.7.1 Household Data Collection Methods

Households were visited to list and identify eligibility. After initial listing, two trained research assistants then visited each household for data collection and sanitation inspections using the structured household questionnaire. However, before commencement of the data collection, respondents' consent to participate was sought. The respondents were asked to identify the source, frequency and quantity of water used in the household as well as type and form of sanitary facilities available for their use.

Sanitary inspections were conducted through visual assessment of the infrastructures and the sanitary state surrounding the household water supply, water holding containers; among other household sanitary conditions taking into account the sanitary aspects and practices in water handling that posed an actual or potential risk to water quality, health and wellbeing of the child.

Further, the respondents were asked whether any of the children in the household had experienced diarrhoea in the last one month prior to the visit. If the answer was yes, the respondent was asked the age of the child at the time of infection, whether treatment was sought and from where and the symptoms and signs of the episode (Ingrid, 2008).

3.7.2 Hospital Data Collection Methods

Health facilities operating within the selected estates were visited to review childhood diarrhea-related morbidity and mortality records. The selected health facilities were purposively and conveniently selected and matched with the particular selected estate as identified in the initial survey. Thereafter a structured data capture form was developed to collect the data (Appendix v/vi).

The key parameters for this review included the residence of the visiting child, diarrhea had been clinically diagnosed, age in months of the child suffering from diarrhea episode and the duration of diarrhea episode. This information was then used to match the hospital case with the selected estate (Table 3.2). All cases that had no information on residence were dropped from this study (Madise et al., 2003).

Further, each case was reviewed to identity the sex of the child, age in months, date of the onset, location and residence of family, duration of the episode and treatment outcome. The data were then cleaned and the information entered on to the research database (Madise et al., 2003).

Table 3.2: Health facilities surveyed in the study area for review of the paediatric records

Study environs	Visited health facility	Matched field study.
LDHI	St. Francis Hospital	Kasarani
	Neema Hospital	Thome
	Glovanna Sylvia Hospital.	Mirema
MDMI	Baba Ndogo Health Centre	Ngumba
	Frema Hospital	Zimmerman
	Marurui Health Centre	Roysambu
HDMI	Mathare North H. Centre	Mathare North
	Kasarani Health Centre	Manguu
	St. John's Hospital	Githurai 44
ISLI	Kiambu District Hospital	Ngomongo/Njathaini
	Kahawa West Health Centre	Soweto/Njuakali
	Kamiti G.K Prison H. Centre.	Kamae

3.8 Water Collection Methods

3.8.1 Water Sampling at Tap Level

A water sample was collected from each household visited. For the collection of water samples, a 250ml glass stopper bottles were used. The bottles were cleaned and carefully rinsed using standard procedure (EMCA, 2007). The bottles were then wrapped in aluminum foils and sterilized in an oven overnight at 170°c. On the day of sampling, the sterilized bottles were packed in a sterilized ice cooler

box and transported to the site of the sampling. At the time of sampling, the bottle caps were carefully removed by hands covered by sterilized gloves.

The tap was turned full and the water allowed to run to waste for two or three minutes. The tap was then turned off. The outside of the bottle was cleaned using dry cloth; the tap was framed with a blow lamp for two minutes. The bottle was filled with the water running gently to avoid splashing (NPHLS, 2008). The stopper and paper cap and label were replaced and dispatched to the laboratory packed ice in an insulated box.

3.8.2 Water Sampling at Container Level

Water samples were collected from the household water container level. In collecting the sample, a sterilized rope was tied around the neck of the sterilized sampling bottle to avoid water contamination. The water sampling bottle was then dropped into the water container. Once the water sampling bottle was full with the water, it was capped with a sterilized cap and then the water sample was clearly labelled (NPHLS, 2008) and transported to the laboratory for analysis.

3.8.3 Laboratory Test

270 water samples were processed at the food and water sampling laboratory of the Nairobi city county. After the samples were received in the laboratory for bacteriological examination of water, they were cultured immediately or stored in a refrigerator to control deterioration. The laboratory preparation procedure involved making dilutions of the sample (1:10, 1:00, 1:000 etc) in sterile water

and culturing in mac conkey nutrient agar and then incubated.. Incubation of the plates was at 37˚c for 24 hours. At the end of the incubation period, visual count of colonies was made. The apparatus, reagents, culture media and glassware involved tubes (18mm by 180 mm), Durham tubes 10mm by 17mm), pipettes 1 ml, (total-flow), incubator 37 + 1°c , brilliant – green lactose bile broth 2%, buffered peptone water, indol medium and reagent, koser's citrate, lauryl sulphate tryptose broth and VP medium.

3.8.4 Test for Total Coliform Count

Simultaneously with the confirmatory procedure brilliant green lactose broth, transfer was made from all positive presumptive tubes to EC medium. The inoculated EC tubes were incubated at 37˚c for 24 hours, and gas formation in the inverted durham tubes was recorded. The bacterial density was estimated from the tables of MPN. For the differentiation of coliform IMVIC reaction was used for reference.

3.8.5 Test for E.Coli

A loopful from each gas-positive tube of LST was transferred to a separate tube of GLB broth. EC tubes were incubated for 48 hours at 44.5˚c production of gas was positive. One plate L-EMB agar was splashed from each positive tube to obtain discrete colonies and incubated 18-24 hours at 35˚c; 2-3 of the suspected colonies from each L-EMB plate was transferred to PCA slants and the slants were incubated for 18-24 hours at 35˚c. At the same time, Gram stains of each culture were made.

3.9 Data management and Analysis

For data management, the questionnaire data were coded and cleaned before entry. After cleaning, the microbial data were linked to households and then entered together with questionnaire data into a spread sheet then transferred to the SPSS 17.0 software for analysis. For the purposes of identification and confidentiality, no names were used.

For data description, the main statistical tools were tables, graphs, percentage, frequencies, mean (median) and standard deviation. For relationships and/or association between variables, Chi square test was performed while for comparisons of quantitative variables ANOVA was performed.

CHAPTER FOUR

RESULTS

4.1 Social Demographic Characteristic of Study Population

Table 4.1 represents a summary of the social demographic characteristics of the study population. Overall, a total of 199 eligible households within the four delineated study environs were identified and enrolled in the study.

Table 4.1: Socio-Demographic characteristics by Residential Environs

	Residential environs			
Variables	**LDHI (31)**	**MDMI (53)**	**HDLI (56)**	**ISLI (59)**
Child mean age in months (mean)	35.64	37.56	35.76	32.16
Child's sex	(48.4%)F (11) (51.6%)M (13)	(50.9%)F(27) (49.1%)M (26)	(58.9%)F(30) (41.1%)M (21)	(52.5%)F (35) (47.5%)M (32)
Respondents Education Level				
Primary (21)	5(16.1%)	8(15.0%)	18 (32.2%)	15 (25.4%)
Secondary (24)	7(22.6%)	25(47.2%)	27 (48.2%)	14 (23.7%)
Other (28)	19(61.3%)	20(37.8%)	11 (19.6%)	30 (50.9%)
Marital Status				
Married (33)	12(38.7%)	31(58.5%)	30(53.6%)	25(42.4%)
Single (21)	10(32.3%)	15(28.3%)	10(17.8%)	18(30.5%)
Other (24)	9(29.0%)	7 (13.2%)	16(28.6%)	16(27.1%)
Household Income				
Below Kshs. 25000 (25)	7(22.6%)	21(39.6%)	30(53.6%)	32(54.3%)
Kshs. 25,001-40,000 (30)	11(35.5%)	19(35.8%)	20(35.7%)	22(37.2%)
Kshs >40,000 (22)	13(41.9%)	13(24.6%)	6(10.7%)	5(8.5%)

A total of 195 children were recorded in the study area. The mean child's age in months was highest in MDMI (37.56) and least in ISLI (32.16) respectively.

With regard to child's sex, the highest proportion of girls was in HDLI (58.9%) and lowest in LDHI (48.4%) while the male constituted LDHI (51.6%) and HDLI (41.1%) respectively suggesting a female to male ratio of 1:1.

For education, most respondents had attained secondary level and above with majority coming from MDMI. However, for the respondents with primary education level, majority were still from the same residential study environ (15.0%). Most respondents from MDMI (58.5%) and HDLI (53.6%) were married. Those divorced, separated and windowed were mainly from LDHI (29.0%) and HDLI (28.6%) respectively.

Majority of the respondents in this study indicated their household monthly income as between Ksh 20,001 and Ksh 40,000. LDHI registered the highest average household monthly income with 41.9% earning an average net monthly income of above Ksh 40,000. ISLI recorded the least household income in this category with only 8.5%.

4.2 Childhood Diarrhea Incidences and prevalence in the Study Area Between 2008 and 2010

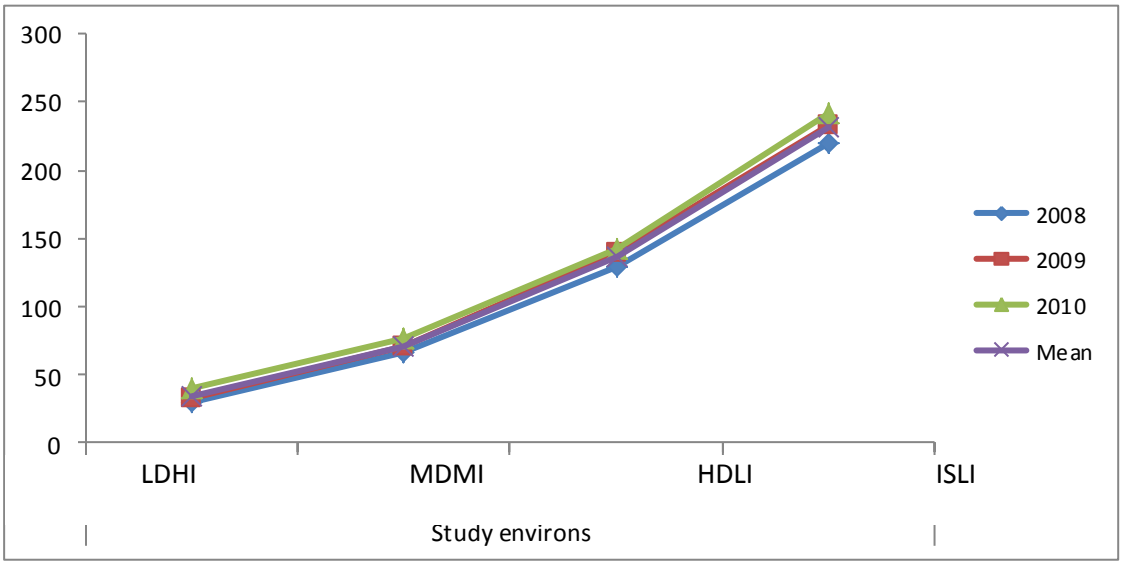

Figure 4.1: Trend of childhood diarrhea incidence in the study area between 2008 to 2010

These research sought to establish diarrhea incidences and prevalence among the under five in the study area. Results obtained showed mounting trend in the number of diarrhea incidences across the four environs at different years. ISLI recorded the highest mean number of incidences of diarrhea while LDHI recorded the least mean number of incidences of diarrhea.

In general childhood diarrhea incidences in the study area indicate a consistent increase over the three year period suggesting a deteriorating sanitation (WASH). There was a significant difference in the mean of diarrhea incidences across the study environs $F=422.995$, $df=3$, $p<0.001$.

Table 4.2: Mean ddiarrhea prevalence in the different residential environs between 2008 to 2010

Year	Residential environ					Significance
	LDHI	MDMI	HDLI	ISLI	Total	F=96.691
2008	40	46	79	140	305	df=3
2009	44	52	91	154	341	P<0.001
2010	53	63	94	160	370	
Mean	46	54	88	151	339	

Table 4.2 above shows the mean childhood diarrhea prevalence distributed by residential environs and years as per hospital records. A one way ANOVA established a significant difference between the means, ($F=96.691$, $P<0.001$). Similar to the childhood diarrhea incidences (Figure 4.1). The results showed a rising trend in diarrhea prevalence across the residential environs with the most affected coming from the informal settlement low income areas (ISLI).

Table 4.3: Post anova analysis for the mean diarrhoea plevalence in the different rsidential environs of Kasarani

Dependent Variable	(I) FACTOR	(J) FACTOR	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
	LDHI	MDHI	-8.000	6.916	.281	-23.95	7.95
		HDLI	-42.333*	6.916	.000	-58.28	-26.38
		ISLI	-105.667*	6.916	.000	-121.62	-89.72
	MDHI	LDHI	8.000	6.916	.281	-7.95	23.95
		HDLI	-34.333*	6.916	.001	-50.28	-18.38
		ISLI	-97.667*	6.916	.000	-113.62	-81.72
	HDLI	LDHI	42.333*	6.916	.000	26.38	58.28
		MDMI	34.333*	6.916	.001	18.38	50.28
		MDLI	-63.333*	6.916	.000	-79.28	-47.38
	ISLI	LDHI	105.667*	6.916	.000	89.72	121.62
		MDMI	97.667*	6.916	.000	81.72	113.62
		HDLI	63.333*	6.916	.000	47.38	79.28

Subjecting the data for the mean diarrhea prevalence to a post Anova analysis using least significance difference procedure (LCD), the findings showed that HDLI and ISLI significantly differed with all other residential environs ($p<0.001$) except LDHI and MDMI residential environs ($p=0.281>0.05$). This implied that children in HDLI and ISLI bore the greatest risk for childhood diarrhea with ISLI being the most affected residential environ.

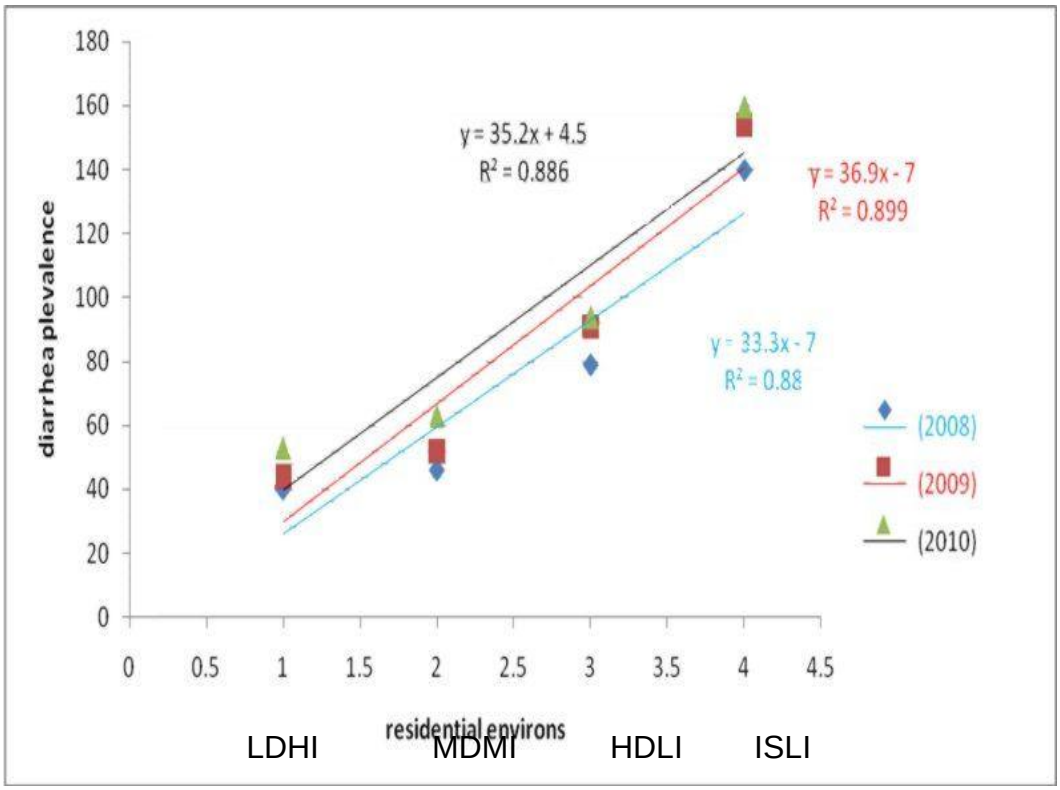

Figure 4.2: Association between childhood diarrhoea prevalence and residential environs from hospital records

There was a strong linear association between ddiarrhea prevalence and different residential environs, R^2 = 0.88, 0.899 and 0.886 in the year 2008, 2009 and 2010 respectively. Children in ISLI appeared to be the most affected by ddiarrhea with children in LDHI being least affected (Figure 4.2). There was an observed general increase of ddiarrhea prevalence in all the study environs in the same period respectively.

4.3 Diarrhoea risk Factors Associated with WASH Conditions in the Study Environs

4.3.1 Water supply, quality and quantity.

These study sought to determine diarrhoea risk factors associated with WASH conditions among the under five in the study area. Table 4.4 shows the results of diarrhoea risk factors associated with WASH conditions in the study area.

Table 4.4: Water Supply and Quality Indicators

Variable	Residential environs				Significance level
Amount of water a family uses per day	LDHI (31)	MDMI(53)	HDLI (56)	ISLI (59)	
Mean Litres/Day	92.64	80.26	78.53	60.75	$\chi2$=293.732, df=3 P=0.001
Whether households treat water before use					
Yes	22(70.96%)	38(71.7%)	45(80.4%)	54(91.5%)	$\chi2$=15.212, df=3, p=0.001
No	9(29.04%)	15(28.3%)	11(19.6%)	5(8.5%)	
Methods of water treatment					
Boiling	26(83.9%)	33(62.3%)	38(67.9%)	35(59.3%)	$\chi2$=16.2662, df=3, p=0.002
Other	5(16.1%)	20(37.7%)	18(32.1%)	24(40.7%)	
Water shortage frequency					
Less than three days	20(64.5%)	40(75.4%)	37(66.1%)	43(72.9%)	$\chi2$=16.2662, df=3, p=0.001
Other	11(35.5%)	13(24.6%)	19(33.9%)	16(27.1%	

The table above 4.4 describes the state of water supply and quality in Kasarani the study area Results as obtained indicated that all the households had water

supply. Significant associations occurred between quantity of water use and environ (P<0.05), water treatment and environ (p<0.05), and frequency of water shortage and environ (p<0.05) respectively. These results further indicated that ISLI had less favorable attributes with regard to water supply and quantity compared to LDHI study environs.

4.3.2 Diarrhea Occurrences in the Study Area by Residential Environs

Table 4.5: Shows the Diarrhea occurrence of the under five disaggregated by study area

Variable	**Residential environs**				**Significance level**
Diarrhoea episodes	**LDHI(31)**	**MDMI(53)**	**HDLI (56)**	**ISLI(59)**	
Occurrence of Diarrhoea in the last one month					
Yes	5(16.1%)	20(37.7%)	23(41.1%)	29(49.2%)	$\chi2$=16.046, df=3, p=0.001
No	26(83.9%)	33(62.3%)	33(58.9%)	30(50.8%)	
Age of the child during infection					
Months(mean)	36	34.68	30	29.16	$\chi2$=32.982, df=21, p=0.046
Attribution to the Diarrhoea					
Poor sanitation and hygiene	14(45.2%)	27(50.9%)	30(53.6%)	39(66.1%)	$\chi2$=0.5623, df=3, p=0.905
Water quality	17(54.8%)	26(49.1%)	26(46.4%)	20(33.9%)	

This research sought to establish whether the under-fives in the study area had experienced diarrhea episodes in the last one month of the study. Results indicated that diarrhea had occurred with significance association with residential environ (χ=16.046; df=3; p=0.001). Older children were more affected in LDHI than in ISLI. However, when respondents were asked what they attributed occurrence of the diarrhoea to, there was no significant difference in response

with all areas reporting both poor sanitation and water quality as possible contributing factors ($p>0.05$).

4.3.3 Household Sanitation Coverage

Table 4.6: Shows household sanitation coverage in the study area environs

Variable	Residential environs				Sig. level
Type of the toilet	**LDHI(31)**	**MDMI(53)**	**HDLI(56)**	**ISLI(59)**	
Flush toilet	26(83.9%)	36(67.9%)	40(71.4%)	10(16.9%)	$\chi2$=16.2662, df=3, p=0.001
Other	5(16.1%)	17(32.1%)	16(28.6%)	49(83.1%)	
Adequacy of the toilet facility					
Adequate	25(80.64%)	40(75.5%)	42(75.0%)	47(79.7%)	$\chi2$=4.088, df=3, p=0.001
Not Adequate	6(19.36%)	13(24.5%)	14(25.0%)	12(20.3%)	
Washing of hands after visiting the toilets					
Always	23(74.2%)	44(83.1%)	45(80.3%)	40(67.7%)	$\chi2$=1.6460, df=3, p=0.649
Other	8(25.8%)	9(16.9%)	11(19.7%)	19(32.3%)	
Disposal of solid waste					
Polythene bag	26(83.8%)	39(73.60%)	40(71.4%)	17(28.8%)	$\chi2$=16.2662, df=3, p=0.001
Other	5(16.2%)	14(26.4%)	16(28.6%)	42(71.2%)	

The study was to determine the level of household's sanitation coverage in the study area. Results as contained in table 4.6 above established that there was good household sanitation coverage. Type of toilet facility, adequacy and household sanitation practices were significantly associated with residential environ. This meant that living in ISLI diminished one's opportunities to quality and adequate sanitation facilities.

4.3.4 Household and Personal Hygiene Practices

Table 4.7: Household and personal hygiene behavior in the study area by residential environ

Variable	Residential environs				Significance level
Issue/statement	**LDHI(31)**	**MDMI(53)**	**HDLI(56)**	**ISLI(59)**	
Insect vectors in the house may pose ill health to a child					
Yes	31(100.0%)	53(100%)	55(98.2%)	59(100%)	$\chi 2=2.566$, df=3, p=0.463
Uncollected solid waste pose a health risk to a child's health					
Yes	31(100.0%)	53(100%)	52(92.9%)	58(98.3%)	$\chi 2=5.041$, df=3, p=0.169

This research was to establish the level of personal hygiene practices and health awareness among the respondents in the households across the study area. Results obtained showed high level of personal hygiene practices and health awareness among the respondents. However, whether the presence of insect vectors in the house and uncollected solid waste posed ill health to a child did not significantly associate with the residential environs ($p>0.05$).

4.3.5 Drinking Water and Household Water Storage Container Sanitary Inspections

Table 4.8: Shows household water storage container in the study area by residential environs

Variable	Residential environs				Significance level
Issue/statement	**LDHI(31)**	**MDMI(53)**	**HDLI(56)**	**ISLI(59)**	
Type of the water container					
Plastic	25(80.6%)	43 (81.2%)	50(89.3%)	49(83.1%)	$\chi 2=7.3697$, df=3, p=0.061
Other	6(19.4%)	10(18.8%)	6(10.7%)	10(16.9%)	
Water container covered or not					
Yes	31(100.0%)	52(98.1%)	53(94.6%)	55(93.2%)	$\chi 2=2.168$, df=3, p=0.538
Accessibility of the water container by other people					
No	30(100.0%)	51(96.2%)	56(100%)	56(94.9%)	$\chi 2=7.705$, df=3, p=0.051

This study sought to establish the sanitary state of the household water storage containers. The findings indicated that households had water containers in their houses. Plastic water containers were most preferred in the storage of water across the four residential environs. However, type of water container, whether the container was covered and whether water containers were accessed by other people did not significantly differ across the four residential environs (P>0.005). Majority of the households had adequate and quality water containers for water storage.

4.4 Household water contamination level

4.4.1 Quality of water consumed by the under five in the study area

This study sought to establish the quality of water consumed by the under five in the study area. To achieve this, water samples were picked from each household visited, at two different levels, tap, and container. The findings of water quality are presented in the table 4.9 below.

Table 4.9: Level of bacterial contamination in water samples for Kasarani study environs

Residential cluster	HHWC		HHWT		Total		T/test
	E-coli	T-coli	E-coli	T-coli	E-coli	T-coli	F=10.140
LDHI	BDL	BDL	BDL	BDL	BDL	BDL	df=6
MDMI	BDL	3.8%	5.7%	7.6%	5.7%	5.8%	p=0.019
HDLI	5.7%	3.6%	3.6%	7.1%	8.9%	11.0%	
ISLI	11.9%	13.6%	BDL	15.2%	12.7%	14.0%	
Total	8.9%	7.2%	4.8%	13.7%	13.3%	16.1%	

Water sampled from LDHI were all negative indicating for E . coli and T .Coli respectively. For the water sampled from MDMI, HDLI and ISLI, the microbial contamination was detected in 13.3% and 16.1% of the water samples for E-coli and T-coli respectively. Approximately 8.9% and 7.2% of water sample collected directly from MDMI, HDLI and ISLI household water containers had both E-coli and T-coli bacteria respectively.

Further 4.8% and 13.7% of the water samples collected directly from the MDMI, HDLI and ISLI household tap water were also positive. The organism ranged between 1 organism/100ml of water to 180 organism/ 100ml of water with a mean of 48.2 organism/100ml for both total coli and E-coli respectively. The study established that non-compliance was significantly higher for household water tap 13.7% Total Coli Bacteria compared to MDMI, HDLI and ISLI household water container 7.2% respectively ($F=10.140$, $p=0.019$).

Across the study environs, the study further established a significance difference for non compliance ($p=0.002$). According to microbial guidelines set by WHO/UNICEF (2008) and also EMCA (1999) Water quality regulations, total and fecal coliform bacteria must not be detectable in any 100ml sample collected from drinking water sources.

4.4.2 Factors Associated With Social Demographic and Household Childhood Diarrhea

Table 4.10: The relationship between several social demographic factors and childhood Diarrhoea

Indicator variable	Number of children	Diarrhoea prevalence	Significance
Caregiver level of education			**$\chi 2=2.103$, df=3, p=0.551**
Primary	21	0.11	
Secondary	24	0.12	
Other	28	0.14	
Marital status			**$\chi 2=1.253$, df=4, p=0.513**
Married	33	0.17	
Single	21	0.11	
Other	24	0.12	
Household average net monthly income			**$\chi 2=3.274$, df=3, p=0.740**
<Kshs. 25,000	25	0.13	
Kshs. 25,000 – Kshs. 40,000	30	0.15	
>Ksh. 40,000	22	0.11	
Childs age (Months)			**$\chi 2=32.982$, df=5, p=0.046**
<12 months	23	0.12	
12 - <36 months	30	0.15	
36 - <60 months	21	0.11	

This research sought to determine whether social demographic factors influenced childhood diarrhea in the study area. Results showed that level of education, marital status and household net monthly income did not have significant association with childhood diarrhoea in Kasarani study area $p>0.05$. However age of the child influenced childhood diarrhea $p=0.046$.

4.5 Childhood diarrhea risk factors associated with WASH conditions

Table 4.11: Relationship between diarrhea and WASH conditions

Indicator variable	Number of children	Diarrhoea prevalence	Significance
Household daily water consumption rate (litres/day)			**$\chi 2=293$, df=3, p=0.001**
< 40	23	0.12	
41 - < 70	40	0.21	
> 71	30	0.15	
Method of water treatment			**$\chi 2=15.212$, df=3, p=0.002**
Boiling	34	0.17	
Use of chemicals	23	0.12	
Others	31	0.16	
Frequencies of water shortages			**$\chi 2=31.762$, df=3, p=0.001**
Once daily	26	0.13	
>One day <one week	20	0.10	
>one week	24	0.12	
Type of the toilet			**$\chi 2=14.563$, df=3, p=0.001**
Pit latrine	33	0.17	
Flush toilet	21	0.11	
Others	36	0.18	
Storage of solid waste			**$\chi 2=22.4577$, df=3, p=0.001**
Ground	22	0.11	
Covered bin	23	0.12	
Polythene bag	30	0.15	

One of the objectives of this study was to determine whether there was an association between Water, Sanitation, and Hygiene and childhood diarrhea. The findings were that (WASH) factors were found to be significantly associated with the childhood Diarrhea. These factors were: Household daily water consumption

rate (litres/day), Child's age, Method of water treatment, Frequencies of water shortages, type of the toilet, and method of Storage of solid waste.

The study observed that the higher the amount of safe water a household consumed per/day, the lower the risk of contracting diarrhea. Older Children were at a higher risk of contracting Diarrhoea compared to younger ones. Frequencies of water shortage were a risk factor for childhood Diarrhoea with frequencies of less than three days posing more risk for childhood diarrhea.

4.6 Discussion of the findings

4.7 Diarrhoea cases in the Study Environs

4.7.1 Trends of childhood diarrhea incidence and prevalence in kasarani.

These findings determined that there was a significant difference in the mean incidences of diarrhoea among the four residential environs. The study observed that childhood diarrhoea incidences were influenced by the residence environmental characteristics with consistent increase from the LDHI to the ISLI. Similar situation is reflected in the field study which suggests that most of the diarrhea cases are influenced by inadequate Water, Sanitation and Hygiene factors. These findings were consistent with childhood diarrhea data from UNICEF 2008 that observed association between lack of water, poor sanitation, hygiene and childhood diarrhea.

These results also displayed a rising trend of diarrhea prevalence from 2008 to 2010 in the hospital records. There was observed a strong linear association between the number of diarrhea prevalence and the residential environs. This is an indicator of a deterioration of Water, Sanitation and Hygiene conditions in the area. This findings agrees with a study in Benin (2003) where it was observed that in developing countries, social, economic and geographical factors impact on diarrhoeal prevalence with the low economic income levels experiencing as high as 134 to 330/1000 cases respectively.

4.8 WASH risk Factors Related to Childhood Diarrhoea in the Study Environs

4.8.1 Relationship between childhood diarrhea and WASH risk factors.

All the households used piped water from Nairobi water and Sewerage Company but there were significant differences with regard to the water usage, shortage, frequency of supply and treatment. It was not clear why there was this difference given that one service provider was responsible but could be explained by infrastructural development, tariffs, and rations. It is worth noting that water supply to informal settlement of Kasarani occurred through public water taps and not household water taps.

Commercial supply of water affect tariff. During field observation, most public water taps were under lock and key. These findings agree with a study by World Bank 2005 that observed that urban poor are normally disproportionately underserved with water services. With regard to access to sanitation and hygiene services, the study established a significant difference between access to sanitation and hygiene services and respective study environs, with majority from ISLI sharing the sanitation facilities.

Although there exists National policy on sanitation in the study area, its implementation is largely lacking. Meanwhile, within Kasarani study environs, there was a huge gap between the rich and the poor in the access to sanitation and hygiene services. This was even more important considering that the urban poor

live in crowded slums and informal settlement where sanitation and hygiene services are particularly important for children's health (Akunga, 2009).

These findings supported both UNICEF, 2008 report on childhood diarrhea and WORLD BANK, 2003 on water, sanitation and hygiene which observed that without adequate quantities of water and proper sanitation and hygiene, infections such as diarrhoea spread easily. In some areas, the prevalence rate is as high as 52% (AMREF, 2011).

On diarrhoea occurrence, the results show that most cases of childhood diarrhoea were experienced in ISLI and HDLI compared with LDHI and MDMI respectively. Notably, these were the same areas where water availability was stressed besides other vulnerable environmental characteristics. This is a very important factor in transmission of waterborne and water-related diseases. These findings support several other studies that suggest that quality of water and the general level of household hygiene affect exposure to Diarrhoea pathogens (Teran, 1991; Diame. et al., 1990; Timacus & lush, 1 995).

These results showed that the age of a child presented a risk for childhood Diarrhoea. Children between the ages of 29 to 36 months were more likely to contract diarrhoea. This could be attributed to the stage when the child is interacting with his environment hence vulnerability to contamination indicating poor and unhygienic environment.

These findings confirm earlier studies which found an association between the age of the child and diarrhoeal incidences (Tagoe, 1995) suggesting that the ability of the child to interact with the environment may increase the probability of contamination. Water treatment practices and methods were also observed to present a risk for childhood diarrhoea with households using water settling method presenting the highest risk for childhood diarrhoea. This can be explained that settling as a method of treating water does not eliminate all the possible water pathogens hence causing risk in the water uses.

Quantities and frequencies of water supply also presented a risk for childhood diarrhea. Households consuming less than 60.75 litres of water per day presenting a higher risk for childhood diarrhoea. This was also the case with those experiencing water shortages for less than three days. This implied that less water implicated proper sanitation and household hygiene level (Sumile et al., 2005, Giat et al., 2008). Other factors that presented a risk for childhood diarrhoea were the methods households stored their solid wastes which could have promoted insect vectors compromising sanitation and hygiene practices. These results agreed with a report by Gwako 2010 that observed that 23.3 million Kenyans lack access to safe drinking water and proper sanitation resulting to several deaths (mostly children).

There was a clear linear association between diarrhea prevalence and residential environs with the informal settlement low income experiencing the heaviest

burden of diarrhoea. This could have been due to the insanitary conditions observed during the field study which promoted favourable conditions for childhood diarrhoea (WHO, 2010).

4.9 Household Water Contamination Level in the Study Environs

These results indicated that water sampled from LDHI was not contaminated. For the water sampled from the rest of the residential environs, both E. coli and T. coli bacteria were detected. Further, it was determined that contamination of water was more in the public tap water than from the household water container.

It is therefore likely that due to seepage in the broken pipes, contamination was more likely to occur. These findings were inconsistent with a study carried out in Ghana which suggested that risk of water contamination is higher in water containers than in water taps due to poor water storage and mishandling (Blum et al., 1987).

Nevertheless, considering NWSCO was the main source of water supply in the study area, it is suspected that the microbial results observed could be a function of contamination in the distribution network or household and personal hygiene practices among the MDMI, HDLI and ISLI residents respectively.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

- Age of a child presented a risk for childhood diarrhea with children between the ages of 29-36 months likely to contract diarrhea. This study concluded that there was a relationship between the observed childhood diarrhea, water, sanitation and hygiene conditions prevailing in Kasarani Division, Nairobi County.

- These study findings established that NWSCO was the main source of water supply for all the Kasarani study environs. Regular water shortages were found to be more frequent in ISLI and HDLI study environs than LDHI and MDMI.

- Water treatment practices and methods across the four residential environs presented a risk for childhood diarrhoea. Meanwhile, high rate of diarrhoea occurrence in ISLI was attributed to inadequate quantities and qualities of water besides the other environmental factors.

- The study also determined that water consumed in Kasarani MDMI, HDLI and ISLI study environs is a potential risk for childhood diarrhoea and with the main source of water for the Kasarani study environs being NWSCO, the microbial results observed was suspected to be a function of

contamination in the distribution network or household and personal hygiene practices among the residents.

5.2 Recommendations

- The disparity in water supply and interruption to different residential environ was found to be the factor that is strongly associated with childhood diarrhoeal incidences. This study recommends that NCWSC institute programs, projects and implement the necessary by-laws that will facilitate adequate and wholesome water supply and distribution services to MDMI, HDLI and ISLI residential environs respectively as a matter of policy to attain the MDG on water and sanitation whose goal is to reduce by half the proportion of people without access to safe water and basic sanitation by 2015.

- The government should expand the existing child health programmes and put more emphasis on environmental sanitation components targeting mothers and child caregivers on better ways of handling children between the age of 29-36 months who were established to be at a higher risk than older and younger children probably due to exposure to environmental contamination.

- The government should support the private sector and NGOs that deals with water, sanitation and hygiene program through enhanced private

partnerships in establishing public toilets and other forms of conservancy particularly in the informal settlements low income areas.

- Health policy makers should encourage unified and well-coordinated mechanisms with other relevant stakeholders such as Ministry of Public Health and Sanitation, Ministry of Housing, Local Government, Ministry of Finance and Planning to incorporate public health education and economic empowerment component to the existing water supply, sanitation and hygiene programmes and projects.

5.3. Recommendation for Further Research

- A study to determine to what extent income levels in the different residential environs in Kasarani affects childhood diarrhea
- A study to establish the extent to which storage of solid waste within households in Kasarani affects childhood diarrhea.
- A study to determine to what extent the disparity and interruption of water supply by NWSCO to different residential environs in Kasarani impact on diarrhoea among the under five.
- A study to establish to what extent the type and adequacy of toilet facilities affects childhood diarrhea in the study area.

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Appendix I

Questionnaire for Household

Please tick appropriate answers or fill in where appropriate.

Cluster……Household No. ……..Plot No…..Date& Time ……

PART A	**Respondents General Information**	**Coding Method**
1.	Does this household have any children under five years? a. Yes b. No	 1 2
If no, proceed to the next household please		
2.	How many children under five years of age are in this household?	Girls ------- Boys --------
3.	How old is each child?	1- …...months 2- …...months 3- …...months 4- …...months
4.	What is your relationship with this child? a. Mother b. Father	1 2 3

	c. Care giver d. Others (specify)	4
5.	What is your level of education? a. Primary b. Secondary c. College d. University	 1 2 3 4
6.	What is your marital status? a. Married b. Single c. Divorced d. Separated e. Windowed f. No comment	 1 2 3 4 5 6
7.	What is your age? a. 0-19 years b. 20-29 years c. 30-39 years d. 40-49 years e. >50 years	 1 2 3 4 5

8.	What is the average monthly net income from you and your spouse's earnings? Below Ksh 10,000 Kksh 10001 – 25,000 Ksh 25,001 –40,000 Ksh 40,001 – 75,000 Ksh .>75,000	 1 2 3 4 5
Part B	**Water Supply and Quality**	**Coding Method**
9.	Where is your main source of water? a. NWSCO b. Borehole c. Rain water collection d. Water vendor e. others	 1 2 3 4
10.	Approximately how many litres of water do your household use per day?(request to see the water bills)	---------- units
11.	Do you treat your water before use? a. Yes b. No	 1 2
12.	How do you treat the water before drinking or use? a. boiling b. filtering c. use of chemicals d. allowing water to settle	 1 2 3 4 5

	e. no treatment	
13.	Do you experience water shortage/rations a. Yes b .No	 1 2
14.	How frequent is the water shortage? a. Less than three days b. More than one week c. None of the above	 1 2 3 4
Part E	**Diarrhoea Incidences**	**Coding Method**
15.	Did any of your child (ren) under five years of age suffer from diarrhoea illness in the last one month? a. Yes b. No	 1 2
16.	If yes, what was the age of the child in months? a. 0 - 11 b. 12 – 23 c. 24 -35 d. 36- 47 e. 48 -59	 1 2 3 4 5
17.	What did you attribute this diarrhoea illness to? a. Poor sanitation b. Poor personal hygiene c. Water quality d. others	 1 2 3 4

Part D	**Household hygiene behaviour**	**Remarks**	**Coding Method**
18..	Is a toilet available in the home/house?	Available Not available.	1 2
19.	If available, of what type?	Pit latrine Flash toilet No comment	1 2 3
20.	In what sanitary state is the toilet?	Very Clean Clean Dirty	1 2 3
21.	Is the toilet facilities adequate for the household?	Adequate Not adequate	1 2
22.	Are your children below the age of five able to use latrine on their own?	Yes No	1 2
23.	If no, explain how they attend to the call of nature.		
24.	How are the faeces of the under five disposed?		
25.	In your own opinion, do you think young children's faeces are harmful in any way?	Yes No	1 2
26.	Why (please explain)		

27.	When do you often wash hands?	Always after visiting the toilet Before cooking After cooking Others	1 2 3 4
28.	How do you store your solid waste in the plot?	Placed on the ground Contained and covered in a bin Contained in polythene bag None of the above	1 2 3 4
PART E	**Personal Hygiene Behaviour**		
	Statement/Question	**Answer**	**Coding**
29.	I am aware about the importance of personal hygiene in protecting a child's health	Yes No	**1** **2**
30.	I always wash my hands after visiting the toilet	Yes No	1 2
31.	There is no health risk associated with washing of hands before feeding a child	Yes No	1 2
32.	I clean the kitchen and utensils' always	Yes	1

	after use	No	2
33.	The presence of insect vectors in the house may pose ill healthy to a child	Yes No	1 2
34.	Use of clean water to washing the utensils is important to a child's health	Yes No	1 2
35.	Uncollected solid waste pose a health risk to a child's health	Yes No	1 2
36.	Adequate, well maintained and clean sanitary facilities are pre-requisite for good health of a child	Yes No	1 2
Part F	**Household Water Storage Container**		
	Observation/Question	**Remark**	**Coding Category**
37.	Is there water storage container in your house/room?	Yes No	1 2
38.	What is the type of container storing the water?	Metal Plastic Others	1 2 3
39.	What is the container's sanitary state?	Clean Dirty	1 2
40.	Where is the water container stored?	Inside the house In the compound	1 2
41.	Is the water storage container also being	Yes	1

	used to store any other material?	No	2
42.	Is the water container covered with lid or not?	Yes No	1 2
43.	Do other people other than the family members access the storage container and the surrounding?	Yes No	1 2
44.	What is the sanitary state of the receptacles that may be used to draw water from the container?	Clean Dirty	1 2
45.	Is the water storage container used for storing any other liquid/material?	Yes No	1 2

Thank you.

Appendix II

Household Interview Questionnaire

Consent form

Good morning/Afternoon/Evening

I am ----------.I wish to thank you for taking your time to talk to me. We are asking questions to people such as you throughout Kasarani division, Nairobi.

If you agree to be interviewed, I will be asking you questions about yourself, your child, your ideas, attitudes and behaviors on different issues.

This interview is only interested in finding out what are the key indicators of childhood diarrhea among children below five years of age in Kasarani division .This information will be used for my research purposes only. Your opinion and experiences are important to us. Your answers will be confidential .your participation in this study is voluntary. The questions you will be required to respond to are personal but mainly about water, personal hygiene and sanitation. If you are uncomfortable with a question, you do not have to answer it if you wish. You may also stop the interview at any time.

Signature of the respondent ……..

Date: ……..

Appendix III

Patient Data Capture Form

Required particulars	Information	Remarks
Health facility		
Date of visit		
Patients name		
Patients age		
Area of residence		
Disease diagnosis (code)		
Suspected cause of disease		
Date of admission		
Treatment administered		
Patient recovered /died		
Date of discharge /death		
Cause of death		

Appendix IV

Age –specific diarrhea hospitalization associated with WASH among children age 0-59 months in selected hospitals in Nairobi

Age group (months)	No. of diarrhea hospitalizations	Reported date of onset	No. of days admitted in hospital
0-11			
12-23			
24-35			
36-47			
48-55			
TOTAL			

Appendix V

Laboratory materials

Reagents/Media	Equipments	Glasswares
Mackonky Agar	Incubator	Sampling bottles (250ml)
Mackonky broth	Water Bath	Durham tube
Brilliant green bile broth	Centrifuge	Pipettes – 5, 10, 25ml
Plate count agar	Ovens	Petri dishes
Peptone water dilunte	Drinking cabinets	Beakers
Nitrate agar	Weighing machines	Measuring cylinders
Nitrate broth	Bunsen burner	Test tubes
Azide Dextrose broth	Glass blowers	Slides and cover slips
Ph kits	Sampling kit	
Sugars indicators	Colony counters	
Indole reagent	Microscope	
	Distillers	
	Racks and buckets	
	Match box	
	Inoculating	
	Loops and wires	
	Hot plate	
	Time	
	Refrigerator	
	Ice parks	
	Disinfectant	
	Jars	
	Grease proof papers	